Renewable and Sustainable Energy Reviews 27 (2013) 569–575

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Business structure in renewable energy industry: Key areas

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ARTICLE INFO

Article history:
Received 13 February 2013
Received in revised form
8 July 2013
Accepted 14 July 2013
Available online 7 August 2013

Keywords:
Diffusion of renewable energy technologies
Business structure
Investment
Private sector

ABSTRACT

Diffusion of renewable energy utilization is difficult because of its entrepreneurial nature and related technological, investment, political, and market uncertainties. Therefore, evaluation of business structure based on traditional business models is difficult in this industry. Although many countries have actively developed renewable energy technologies by both governments and private sector, business professionals are not still assured about participation and investment. Understanding the areas of business structure that lead to successful commercialization of renewable technologies has suitable research scope in this industry. The objective of this article is to identify key areas of business structure to allow newcomers to enter successfully in the renewable energy industry from engineering, policy, and business aspects. The innovative analysis leads to identification of seven sides of renewable energy business.

Contents

1. Introduction

Today a meaningful growth exists in energy demand and consumption caused by economic and social development especially in developing countries. The limitations of carbon-based fuels as the main supply source of energy consumption have motivated scientists, politicians, and economists to think of ensconced alternatives with lower potential risk. For instance, the carbon-based fuels are not harvestable in all countries, nor are they sustainable in the producer countries. Further, continuous fluctuations in prices as well as increase in other costs (e.g., transportation) make the fossil fuels more unreliable [1]. On the other hand, environmental, technological, and political dangers of nuclear energy make the utilization of other reliable energy resources a necessity.

To respond to the challenges and achieve the security of energy supply, diversification and utilization of renewable energy resources (RER) are two of the important debates among policy makers and researchers. Free and local availability, cleanliness, eco-friendliness, and sustainability of RERs caused some economists and policy makers to admit that the only way to reach sustainable development is the maximal consumption of RERs.

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http://dx.doi.org/10.1016/j.rser.2013.07.021

For instance, about 100% and 96.6% of the demanded electricity in Norway and Iceland were supplied by sustainable resources in 2010 [2]. There are also noticeable efforts and long-term plans in other countries in Europe, Asia, and North America for utilization of RERs. According to former future energy policies, development strategies of renewable energy (RE) are an important part of the US energy security action plan.

On the other hand, statistics show that about 56% of rural households and 400 million people are without electricity access in the world [3]. While rural areas have challenges such as low per capita consumption and inadequate power supply, RE utilization provides social welfare equity among local people.

However, despite successful efforts in diffusion of RE utilization, there are remarkable gaps between achievements and plans. Beyond the technological issues, RE industry needs strong capital and investment with core role of private sector. In other words, to use RERs economically, they should be diffused pervasively by the contribution and support of the private sector. As an example, the share of private sector in electricity generation and distribution in the US is approximately 80% and nearly 75% of the electricity sale [4]. This percentage is very low in developing countries. For instance, less than 3% of the investment and operation in energy industry is performed by the private sector in the Middle East [5].

Since RE industry offers a profitable future from both security and rural area development aspects, sufficient possibility and potential exist for private sector investments. However, investors are not assured about participation and investment in this industry [35]. From a private investor's viewpoint, the RE industry is an entrepreneurial industry along with technological, political and market uncertainties in which traditional evaluation of investment and market analysis are difficult [1]. This means that there are important points that an investor wants to consider before investing in the RE industry. To understand the different dimensions of decision making among private investors, researchers have investigated on investor's criteria in this industry [1,6,7]. Fig. 1 shows some important factors of investment from an investor's viewpoint in developing countries. These criteria are classified into three main dimensions: politics and business, engineering, and environment [1].

Investigations show that major concerns of investors to start RE investment are market and business aspects [8]. In other words, profit in short-term and market-based orientation are dominant factors for the private sector to start an investment. Therefore, study of dominant business structure in the RE industry and evaluation of potentials of related innovative technologies are two of the important research scopes for diffusion of RE development [9,10]. Understanding factors leads to successful introduction of new businesses in the RE industry which can help investors to establish and implement plans effectively, minimize risks, and avoid mistakes. In other words, analyzing the business structure of the RE industry can act as a mediating construct between RE technology innovation and economic value via superior value creation as compared to competitors (both in the level of companies and replacement products such as fossil fuels).

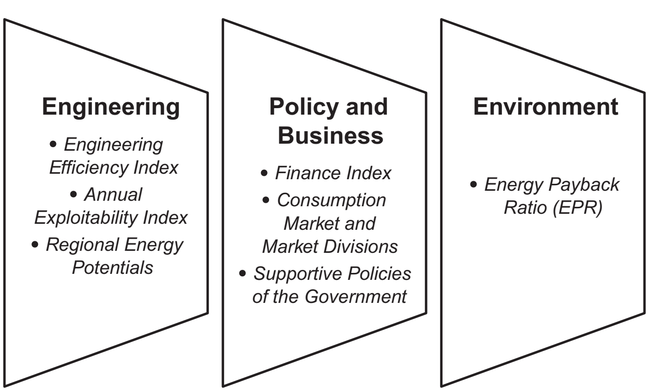


Fig. 1. Investment dimensions and criteria in the RE industry [1].

The overall objective of this article is to identify key elements of RE business. The defined areas of business structure can promote commercialization and diffusion of related technologies in this industry. The work helps mangers, investors, and policy makers to study different aspects of business in the RE industry.

The article is started by a brief definition of the business model and structures in the RE industry (Section 2). Important barriers to have a successful RE business is also introduced in that section. Section 3 presents and describes definition areas of business structure of RE with an innovative framework based on a wide qualitative research.

2. Initial definition of business model

Circumstances of doing a successful business have changed in recent decades because of factors such as competition, faster innovation cycles, and increasing globalization [11]. These factors have made the markets more dynamic, competitive, and complex [12]. For survival, managers and entrepreneurs should produce new business ideas or plans, examining business activities and modifying existing structures and strategies [11]. The business models and structures help managers and firms to identify, analyze, and manage the areas and ideas of successful business activities systematically. In other words, a business model learns how to make money out of a technology or an idea [13].

According to Feldman, the approach of the business model is to unify the resource-based and market-based views of a company or technology [31]. Although development and design of business models and structures have become increasingly important in different industries, there are gaps in the development of RE business in both developed and developing countries [8]. Table 1 summarizes the most important barriers and limitations.

Although studies show that there is no universal or best business structure in energy/RE industry and market, several studies have tried to cover a part of the research gap that exists in the related literature [14]. Some studies address the RE business

Table 1
Important barriers of successful RE businesses.

	Barrier or limitation
1	Budgetary limitations
2	Lack of information on RE market, demand, and potentials
3	Inadequate coordination among the various stakeholders
4	Ambiguous policies and regulations
5	Cost of RE utilization for end-user
6	Conversion efficiency of RERs
7	Operation and maintenance costs
8	Lack of mechanisms to provide modern and efficient energy services in rural areas
9	Inadequate incentive for RERs utilization compared to fossil fuels (e.g., taxation, tariffs, substitutes, and feed in)
10	Absence of policies related to promotion RE energy
11	Low public awareness on RERs
12	Lack of familiarity with green certificates and standards
13	Lack of a robust planning to RE development in the strategic and practical levels
14	Low storage capacity of RE technologies compared to fossil fuels
15	Gaps between research projects and market's needs
16	Poor quality of some RE technologies and utilization
17	Lack of specialized and skilled manpower in RE industry
18	Dominance of old carbon-based energy-inefficient technologies
19	Social and environmental barriers via beneficiary groups
20	Location selection

model from two perspectives: customer and utility [15–17]. According to Richter, the utility perspective of the RE business model comprises large-scale projects (in capacities between one and hundreds of megawatts) [18]. Indeed, the customer business model comprises energy generation in small-scale systems close to the point of consumption. Therefore, four elements of value proposition, customer interface, infrastructure, and revenue model can be introduced in each RE business model [18].

3. Definition areas of business structure in renewable energy industry

The business scopes in RE industry are categorized in three main levels: RE utilization for heat and power generation (current article), biofuels production and their usages, and alternative transport fuels [14].

From investors viewpoint, RE business models and structures should provide qualitative indicators to evaluate potential of the industry and companies to create economic value. Resultant business models should illustrate a heuristic logic towards value creation [32]. Thereby, the aim of this research is to understand the definition areas of business structure in RE industry. Research data come from three primary resources: direct observation of the authors, analysis of statistics reports published by related international agencies (e.g., IEA, EIA), and scientific references in the fields of energy, investment and management. Approximately 5000 pages of documents and articles including annual reports, detailed government, project reports, and published investigations were reviewed. To organize and extract data and create the definition areas, NVIVO 9(QSR) software was used. NVIVO is for qualitative research using rich text-based and/or multimedia information. Higher performance with the ability of managing a large amount of data, time reduction, exactness, and flexibility in data processing, and increase in accuracy and credibility are the main reasons that the researcher preferred to use NVIVO in the current article. Fig. 2 illustrates the research steps used.

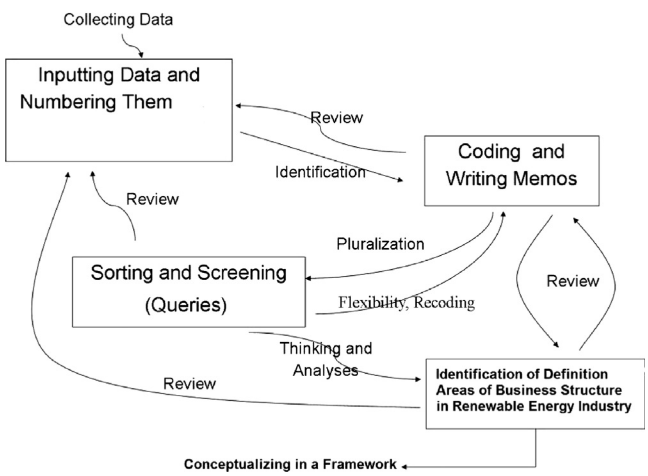


Fig. 2. Qualitative structure of research.

NVIVO helps researchers in three main ways: managing data, managing the ideas, and querying data [19]. First, the authors began to understand the areas of business structure in the RE industry by analyzing barriers of RE development (Table 1), related published articles, observations, and scientific reports. Therefore, seven sides were identified that play as the effective factors in RE business. Fig. 3 illustrates the conceptual framework of the analysis. The emphasis of this model is to identify and evaluate development drivers of doing RE business from supply to end-user with consideration of the core concepts of a successful business in energy industry: clean, cheap, and secure.

3.1. Strategic side

The strategic side of RE business structure creates a road map for other sides and defines the mission and goals of a business in this industry. This side can be defined in three terms: financial measurement, demand analysis, and risk analysis (Fig. 4). Financial measurement (profitability and investment cost) indicates the importance of required investment and expected revenue in RE

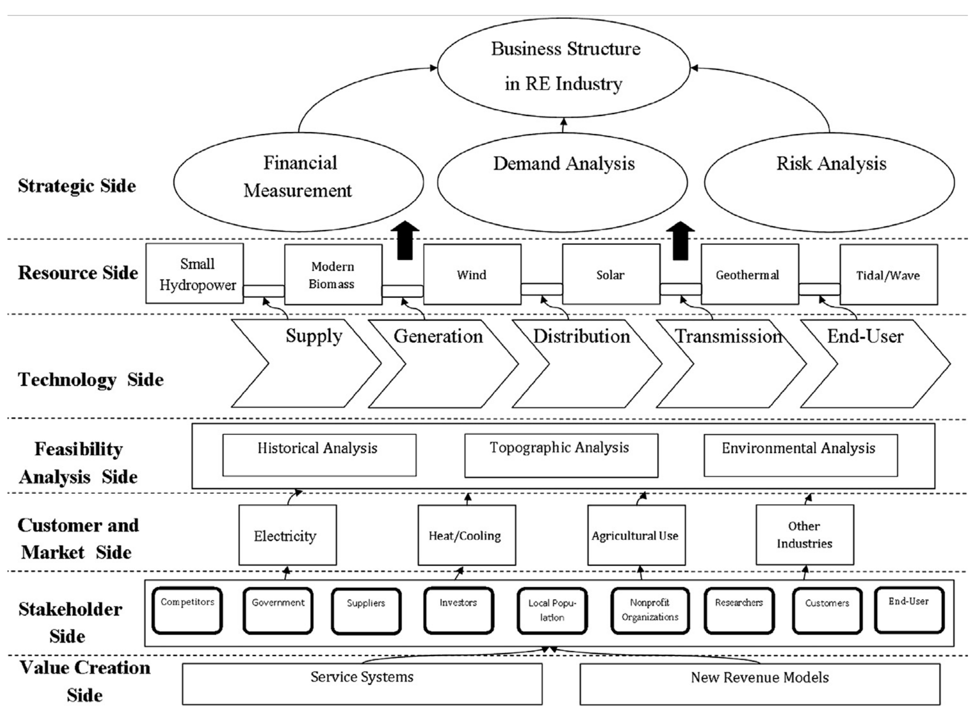


Fig. 3. Definition areas of a renewable energy business model.

business. To improve financial aspects of a business, technology managers and business professionals should reduce costs while keeping innovativeness up, along with the best service proposition. As RE technologies improve with time, the utilization will generally be cheaper with time progress. Therefore, technologies with high cost reduction capabilities are more attractive for investors and commercialization [20].

On the other hand, demand analysis is a key factor in business studies that determines the reasons of success or failure of a product or service. As successful businesses work in an environment with high potential demand, this analysis helps investors and policy makers to show how the sales performance of RE technology can be improved.

Finally, investments on RE technologies are often considered as a high-risk investment because of high technology risk or regulatory risk. Therefore, risk analysis can help business professionals to assess factors that harm the success of a RE business or achieving a goal.

3.2. Resource side

Although about 16% of the world's energy consumption comes from renewable resources, approximately 62% of this energy is traditional biomass that is mainly used for heating. Indeed, around 21% is large-scale hydropower used for electricity generation. However, new renewables including small hydro, modern biomass and biofuels wind, solar, geothermal, and tidal/wave are growing rapidly and providing new opportunities for investments and business profits. In the past, many RE projects were large-scale. However, because of renewable technologies developments, private utilization and developments in rural and remote areas are new targets and markets. Table 2 describes the most important RERs with commercial utilization potential from resource side.

In large-scale business, the dominant sources of RE business are biomass and biogas plants (or CHP plants), on/offshore wind energy, large-scale photovoltaic systems, and solar thermal energy like concentrated solar power. In small-scale business, the dominant sources are wood pellet stoves, small wind turbines, and small-scale combined heat and power systems (CHP), solar thermal collectors, solar photovoltaic systems, geothermal, and heat pumps.

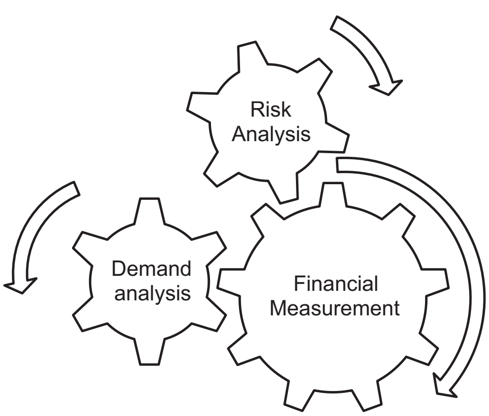


Fig. 4. Strategic side of the RE business model.

3.3. Technology side

The major challenge of RE industry from technology side is to bring new technologies from research and development centers to the market and create value for customers. RE industry creates opportunities for business creation in five main domains as shown in Fig. 5.

The first part of technology side, supply, includes RE resources and their related technologies of exploration and utilization. The second domain, generation, is also called production and factors such as investments costs, operation costs, conversion efficiency, technology limits, and manpower are related effective issues. On the other hand, RE distribution and transmission technologies that can be combined with load management and energy storage systems are other domains of technology side that provide business opportunities for investment. Finally, “end-user” considers management of different appliances within industries, transport, housing etc. The end-user of RE includes two major markets: electricity market and heating market.

For successful diffusion of RE technologies, different technology-push policies, such as government-funded research and development projects, feed in tariffs, and taxation, are suggested in this industry [10].

3.4. Feasibility analysis side

Diffusion of RE utilization is one of the important solutions to achieve the targets of sustainable development in the local areas. In other words, RE development affect several dimensions of the socioeconomic sustainability in the rural areas. As rural areas are not usually energy self-sufficient, diffusion of local RERs to heat/electricity generation provides the possibility of equity and social welfare for the locals and reducing dependency on the imported energy. To achieve this, a feasibility study as the potential evaluation and analysis of a project or decision based on extensive investigation to give full comfort to the energy policy makers has an important role. It aims to identify opportunities, threats, strengths, and weaknesses of a business or proposed venture [29]. The feasibility analysis in RE industry is divided into three main groups: historical analysis, topographic analysis, and environmental analysis. The historical analysis reviews the benefits and

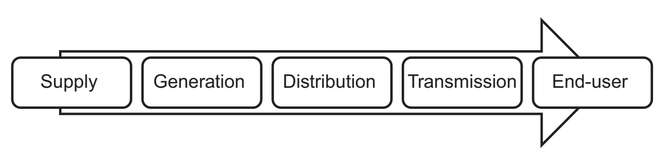


Fig. 5. Technology side of business structure in RE.

Table 2
Short description of each RER with commercial utilization potential.

	RER	Short description
1	Small hydropower	Hydropower on a scale serving a small community or industrial plant with electricity generation capacity of up to 10 MW
2	Modern biomass	Use of biomass for electricity generation, heat production, and transportation fuels from agricultural and forest residues and solid waste [28]
3	Wind	Conversion of wind power into a useful form of energy
4	Solar	Conversion of sunlight into electricity or heat
5	Geothermal	Thermal energy generated and stored in the Earth converted to useful forms of energy (electricity or heat)
6	Tidal	Conversion of the energy of tides into useful forms of power
7	Wave	Transport of energy by surface waves, to useful energies

last progresses of a technology in the utilization of RE. Traditionally, RE technologies are not thought of as cost competitive compared to current energy technologies and people are not usually interested in investing if the payback period is too long. Therefore, the historical analysis helps to understand the policy and technological progress of this industry.

The topographic analysis identifies the number of regions in which a RER can be utilized and that are attractive for investment [1]. For instance, while small-scale electricity generators, called Distributed Generation (DG), are one of the potentials of electricity markets in rural areas, the topographic analysis helps business professionals to identify the opportunities of profits and start to think about the investment.

Overall, facilities of RE utilization should be located near sources and installed in an optimized location [26]. On the other hand, some RERs have geographical limitations. For instance, technologies related to geothermal should be developed in areas with high possibility of earthquake and volcanoes [26]. Therefore, topographic analysis can help to select the best location for starting RE business. This analysis may include the issues below:

Resource identification,
Transmission – capacity, curtailment, upgrades,
Construction logistics,
Environmental – no endangered species, avian, archeological.

Finally, before examining different business structures to commercialize RE technology, it is appropriate to understand and analyze limitations and environmental effects of a business or proposed venture. Customer's demands (market and consumer psychology), sustainability, social acceptability, and possible future rules are some issues that should be considered. Table 3 shows some negative environmental impacts of RERs [1,26,27].

3.5. Customer and market side

The customer and market side describes different kinds of renewable products that can be used or implemented by different groups of the customers. While free market is essentially encouraged in the RE market, the government intervention or incentives should always support new technologies and businesses in this market. In such complex market, the capabilities of commercial success are available and provided to/by private sector. Further, while the responses to demands are quick, the prices are kept down through natural market competition.

Recently, small-scale renewable heating and cooling systems have been considered by researchers and policy makers as new markets. The size of the systems ranges from a few kilowatts to1 MW. This provides a good opportunity for business activations of local, small, and medium sized enterprises [33]. Table 4 shows different types of RE services.

In the local level, and as Komor and Bazilian describe, the implementation of RERs also provides the competitiveness of the local business and market that is beneficial for less-developed areas [34]. This means that RE utilization can improve the quantity and quality of employment and business opportunities in the local areas.

3.6. Stakeholder side

Privatisation, competitive markets, as well as governmental efforts are the keys of diffusion of RE utilization in a country with high RERs potential. Therefore, the role of stakeholders, and economic, social, and political relationships between them are very important for the development of RE utilization. The main actors of RE business are competitors, government, suppliers, investors, local population, nonprofit organizations, researchers, and users/customers who are known as main stakeholders. Fig. 6 illustrates the subsystem diagram of RE stakeholders. This diagram shows the major subsystems that correspond to a business or an organization in a social or industrial system [30].

Competitors and their power are two main elements that investors should think about before starting any business. The behavior of competitors and intensity of competition are two subjects that should be considered, particularly during the development process. While profit in short-term and market-based orientation are the dominant approaches of investors, governments and policymakers are paying special attention to achievements of long-term development plans [21,8].

Customers are another group of stakeholders that take the final decision to install and pay for a RE technology. The government is also a part of stakeholders that participates in business structures of RE as regulator and financial incentives provider. Governments must establish an appropriate regulatory environment and institutional infrastructures to support introduction of RE. For example, one of the governmental policies to RE development is

Table 3
Some negative environmental impacts of RERs.

RER	Examples of environmental consequences
Biomass	CO_2 emission (less photosynthesis), global warming, landscape change
Solar	Soil erosion, landscape change, hazardous waste
Wind	Noises in the area, landscape change, soil erosion, killing of birds by blades
Geothermal	Subsidence, landscape change, polluting waterways, air emissions
Hydropower	Change in local eco-systems, change in weather conditions, social and cultural impacts
Tidal/wave	Landscape change, reduction in water motion or circulation, killing of fish by blades, changes in sea eco-system

Table 4
Type of RE services present in the markets and applications.

Biomass	Wind	Solar	Hydropower	Geothermal	Tidal/wave
Electricity	Electricity	Electricity—photovoltaics(PV)	Electricity	Electricity	Electricity
Heat	Windmills	Electricity—concentrated solar power (CSP	Cooling	Heating	Water desalination, or
Biofuel (transport)	Wind pumps	Heat	Fuel cell	Agricultural use	Pumping of water
Commodity chemical			Hydrogen		
Material waste					
Added-value chemical					
Pharmaceutical/nutraceuticals					

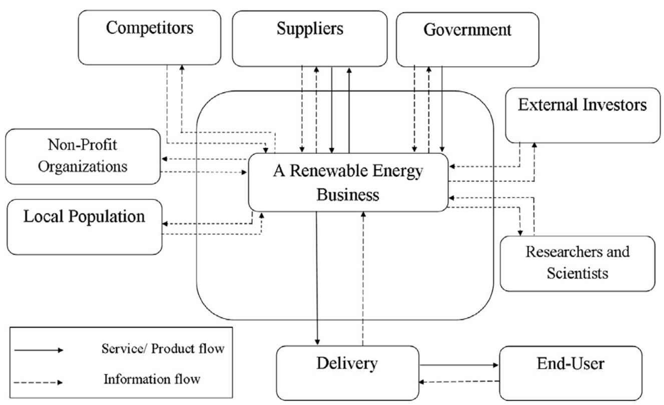


Fig. 6. Subsystem diagram of stakeholders in the RE business.

the feed-in scheme in which a producer from a RER can receive a direct payment per unit of energy produced. The feed can be a tariff such as a price that covers the generating costs or a premium that provides a bonus for the producer.

3.7. Value creation side

RE value creation refers to actions that increase the worth of a RE product, service, or business. The focus of value creation is creating better value for customers and shareholders. From strategic side, value in a RE source is created when it earns revenue for investors. The first step to achieve value creation is to understand the drivers of RE industry and market. Understanding what creates value in each source helps both business professionals and policy makers to focus capital and talent on the most profitable opportunities for growth. Since innovation and high performance are valued for a source, the related process and technology that provide superior functionality take on high values in the renewable industry [22]. As noted before, to have a successful business in RE industry, proposing the best technology is not enough. The quality of services is also an important factor especially from values creation and strategic sides. The value in RE industry can also range from consulting services to full-services package including financing, ownership, and operation of a RER. Research done by Wuestenhagen and COWI shows that the value creation in RE industry is categorized into two main groups: value creation based on service systems, and value creation based on new revenue models [23–25]:

Value creation based on service systems offers services beyond the simple sale of electricity utilized from RE sources. Energy supply (e.g., electricity, heat or steam sales under a long-term or short-term contract to a customer or end-user), and energy performance (e.g., delivering energy savings compared to a predefined scheme) are examples of value creation.

Value creation based on new revenue models offers value creation in new frames. Due to government incentives to RE development, there are business opportunities that can contribute new revenues for investors (e.g., companies that consult and issue green certificates for houses).

4. Conclusion

This article tried to answer to one of the important questions of energy investors and policy makers titled “Which criteria help investors and business men to design, implement, operate, and control their businesses in a successful manner in the renewable energy industry?” As discussed, renewable energy can bring a wide range of business and economic opportunities at different levels, in particular at the regional level. Our findings showed seven sides of renewable energy business to identify the areas of renewable energy opportunities. Our study showed that successful businesses are those that respond to customer needs and market demand. Indeed, while a successful renewable energy business should understand and control key elements of the value chain, they should be flexible for any changes in their structure and product prices over time.

For future research, the social opportunities of renewable energy utilization such as local public acceptance and tourism of renewables can be analyzed. From policy analysis, embedding of the energy strategies in the local business and economic development is recommended. Indeed, the opportunities of RE can be analyzed from supply chains viewpoint at both country and regional levels.

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